AD-A258 619

WHOI-89-34

1930

Woods Hole Oceanographic Institution

The Surface Acoustic Shear Sensor (SASS) as used during the Shelf MIxed Layer Experiment

November 1988 – March 1989

Ellyn T. Montgomery
and
Markku J. Santala

July 1989

92-31914

Technical Report

Prepared for the National Science Foundation under Contract Number OCE-8716937.

92 12 17 038

WHOI-89-34

The Surface Acoustic Shear Sensor (SASS) as used during the Shelf MIxed Layer Experiment (SMILE) November 1988 - March 1989

Ellyn T. Montgomery
and
Markku J. Santala

Department of Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

July 1989

Technical Report

Prepared for the National Science Foundation under Contract Number OCE-8716937.

Approved for Distribution:

Albert J. Williams 3rd

Albert J. Williams 3rd, Chairman
Department of Applied Ocean Physics
and Engineering

Contents

List of Figures

List of Tables

Abstract

The SMILE (Shelf MIxed Layer Experiment) field program took place during the winter of 1988 - 1989. The SMILE program itself was large and involved many investigators and instruments. This report documents the use of the Surface Acoustic Shear Sensor (SASS) as part of the suite of measurements taken during SMILE.

The SMILE mooring array was deployed from early November 1988 until June, 1989. SASS, being a newly developed instrument, was deployed for two shorter periods; a test deployment between November 26 and December 8, 1988, and a longer second deployment, February 23 through March 14, 1989.

SASS is based on BASS (Benthic Acoustic Stress Sensor) components (Williams et al., 1987), mounted on a structure that allowed continuous sampling of velocity, temperature and conductivity in the top five meters of the ocean. BASS was modified for this surface application to acquire data from a gyro, and conductivity sensors. The attitude data from the gyro allows the velocities of the current meter to be referenced to an inertial frame of reference. The other data obtained from SASS will be used to calculate shear current gradients, and other descriptors of turbulence and mixing.

1 Introduction

The Surface MIxed Layer Experiment (SMILE) was a multi-investigator experiment that took place off of the coast of Northern California from November 1988 to May 1989. The goal of the SMILE program was to obtain measurements that would describe the mixing in nearshore waters driven by winter storms. The SMILE program occurred in concert with the Sediment TRansport Events on Shelves and Slopes (STRESS) experiment, and the Biological Effects of Coastal Oceanic Sediment Transport (BECOST) experiment. These three studies provide top to bottom oceanic coverage, atmospheric data, and information on benthic communities.

Included in the SMILE program itself were several kinds of instruments. To provide information on the horizontal distribution of mixing, five current meter and meterological moorings were set. Extensive CTD surveys were executed from ship, as were atmospheric surveys from shore. The Surface Acoustic Shear Sensor (SASS) was designed and deployed to measure the small scale mixing processes in the upper 6m of the water column. The location of the SMILE moorings relative to the California coast is shown in Figure 1. The central mooring, labelled C3, was located at 38° 38.71'N, 123° 29.56'W in 90m of water. The SASS mooring was placed as close as possible to the C3 so that the data from the two sets of instruments would nominally describe the same parcel of water. Times and locations of the SASS deployments are noted in Table 1.

TABLE 1: SASS deployment dates and positions

	Date Deployed		Date Recovered		Position
Initial deployment	11/27/88	16:00	12/3/88	15:30	38° 38.88' 123° 29.32'
Initial deployment (batteries recharged)	12/4/88	15:30	12/9/88	16:00	38° 38.93' 123° 29.38'
Final deployment (with LOPACS)	2/23/89	21:40	3/13/89	15:30	38° 38.83' 123° 29.27'

Within this report only the SASS component of SMILE will be covered. Other aspects of SMILE will be documented elsewhere.

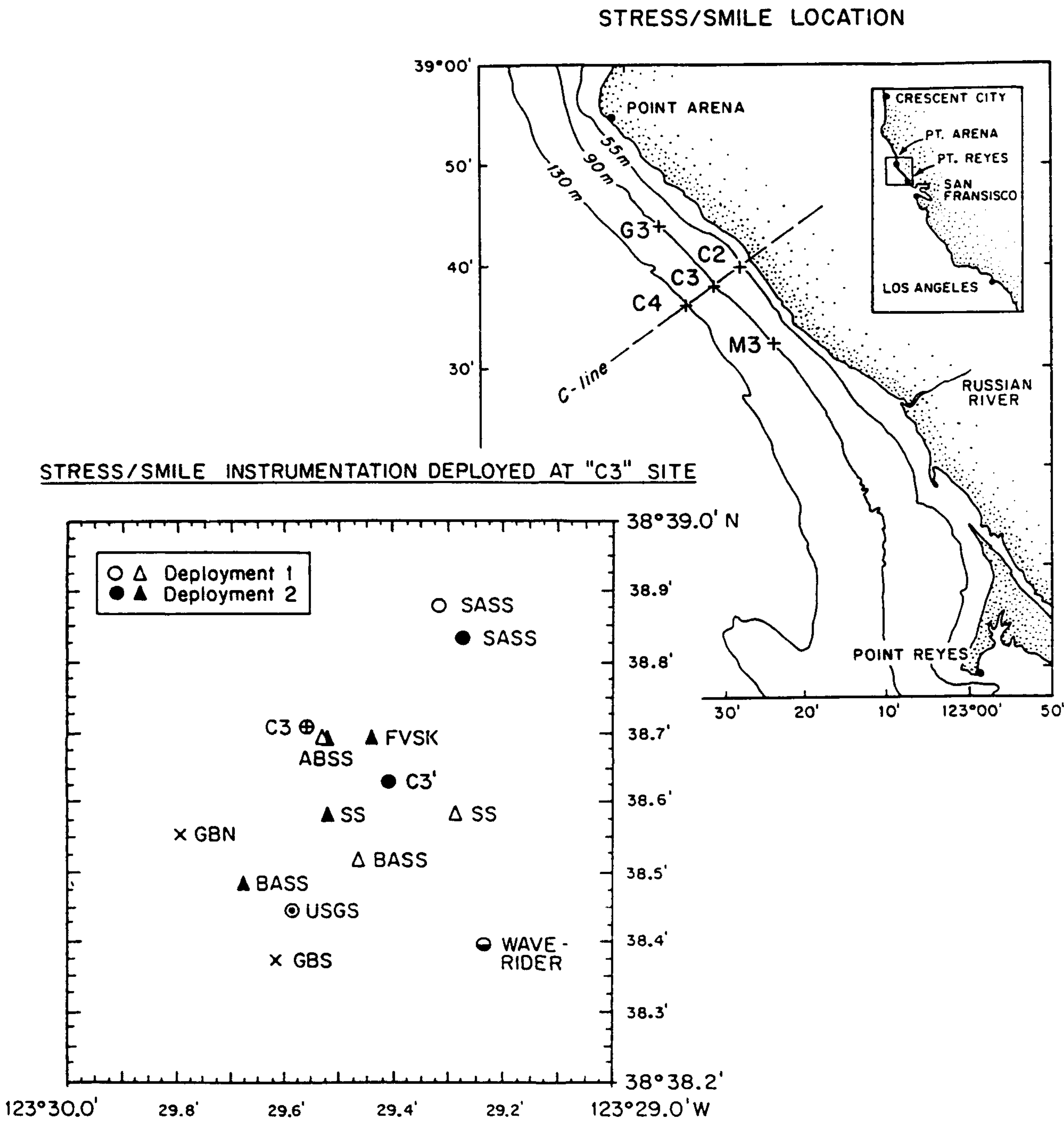


Figure 1: Chart showing SMILE mooring positions. Inset shows the locations of STRESS and SMILE instruments near C3.

2 Goals of SASS

The first goal of SASS was to measure the shear current and temperature profile in the upper 6m of the ocean. Secondly, estimates of the level of turbulent mixing in this region were to be computed. As SASS, shown schematically in Figure 2, is a surface following float, an ancillary task to the two mentioned above will be to make estimates of the wavefield.

3 SASS Instrument Description

3.1 SASS Sensors: Type, Quantity and Location

The SASS is constructed around the BASS current meter (Williams et al., 1987). The BASS current meter is an acoustic travel time current meter which measures vector velocities with a spatial averaging scale of roughly 20 cm. This relatively small sampling volume along with the sampling rate of 4 Hz (as BASS is configured for the SASS deployment) allows us to examine the turbulent nature of the boundary flow as well as to determine the long-term averages. A typical BASS current meter sensor is shown in Figure 3.

Referring back to Figure 2, we see that there were actually six velocity sensing "pods" in the current meter array. The sensing pods were separated by spacer cages to give the spatial separation of sensors indicated in the table below:

TABLE 2: SASS Sensor Depths

Sensor	Distance Below Still Water Level
Wavestaff	57 cm to 63 cm
BASS pod/metal therm. 1	110.8 cm
BASS pod/metal therm. 2	165.8 cm
BASS pod/metal therm. 3	251.1 cm
BASS pod/metal therm. 4	311.1 cm
BASS pod/metal therm. 5	391.4 cm
BASS pod/metal therm. 6	584.5 cm
Sea-Bird cond./therm. 1	110 cm
Sea-Bird cond./therm. 2	585 cm
Gyroscope reference surface	480.0 cm

The sensing volumes as well as the spacer cages are of stainless steel construction and when connected together make up a very slender truss. The structural members

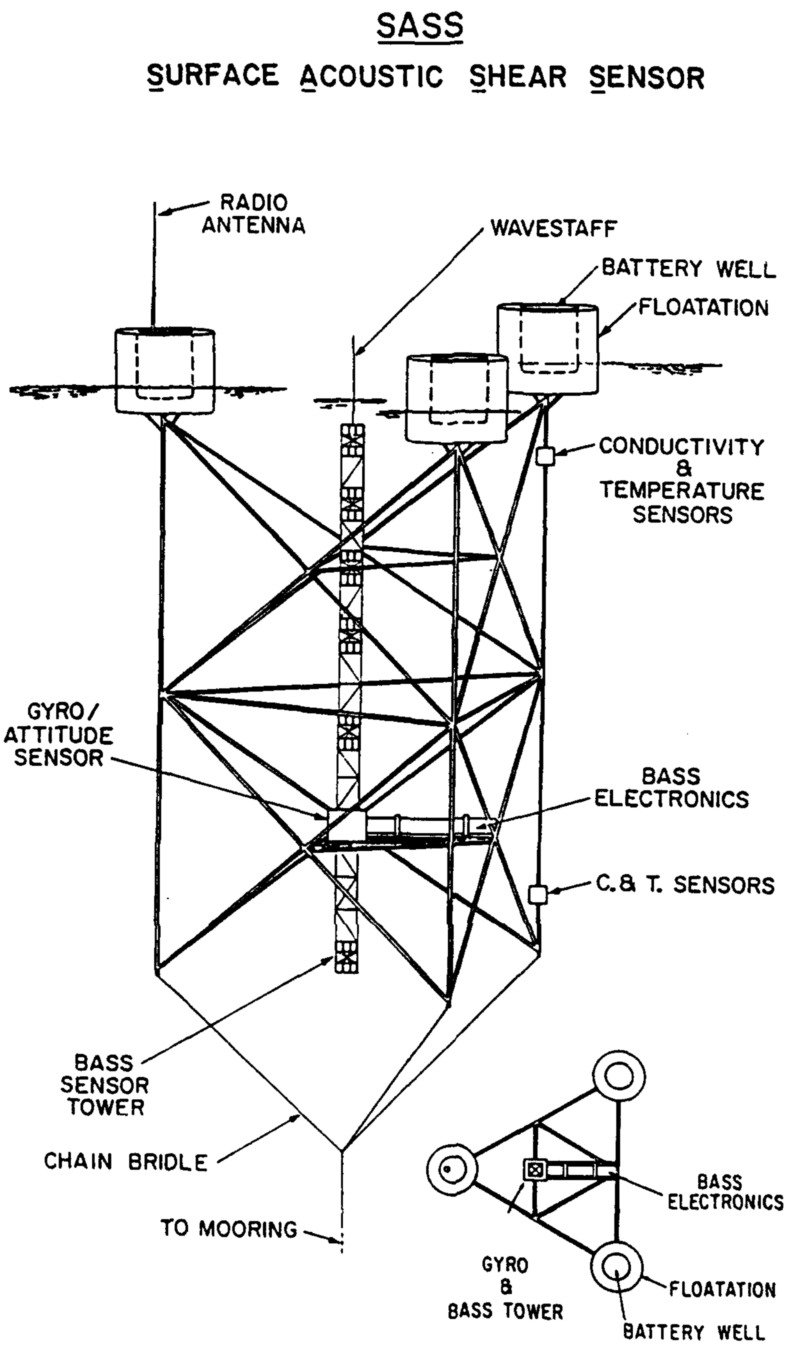


Figure 2: Diagram of the SASS showing the structure, flotation, sensor positions, and radio location.

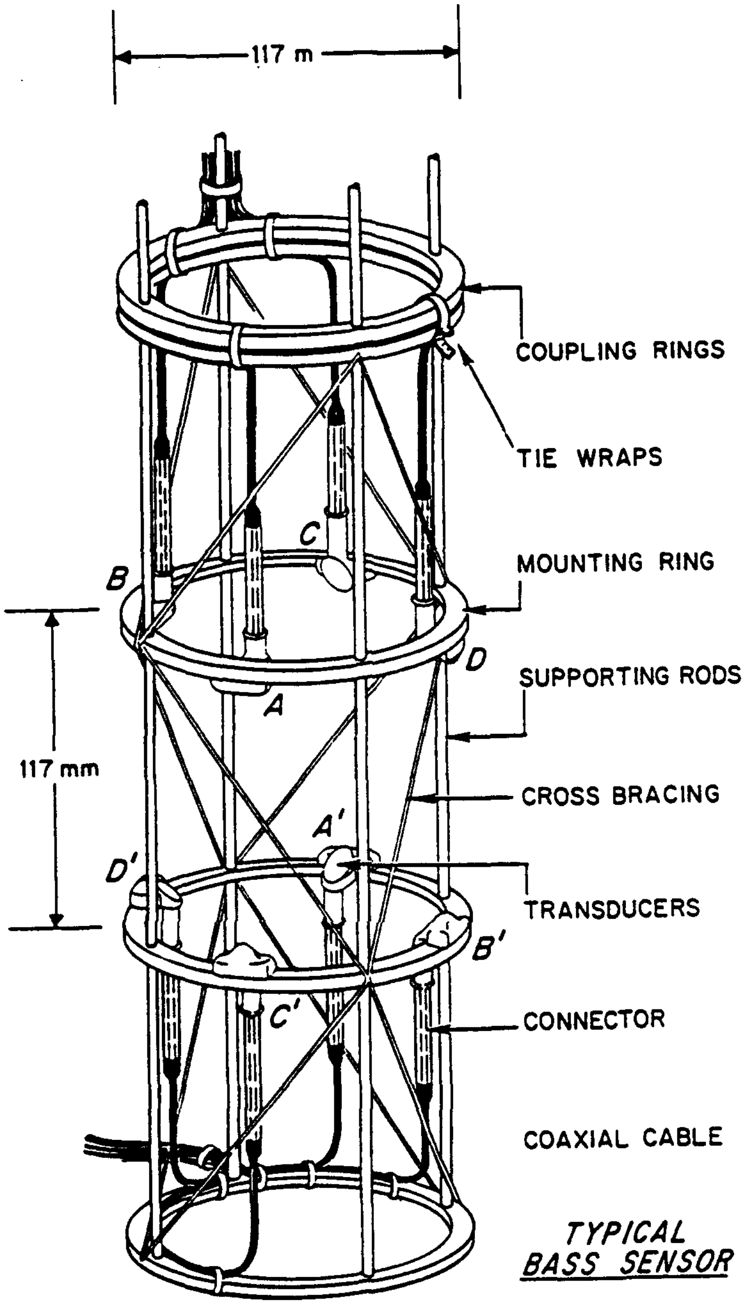


Figure 3: Sample BASS acoustic current meter. Note the diagonal path between matching transducer pairs, each of the four separated by 90°.

of this truss are intentionally kept small in order to keep the flow disturbance to a minimum. However, because of this slight construction it becomes necessary to support the BASS sensor "tower" by the surrounding superstructure which is constructed predominately out of two inch diameter aluminum tubing. The sensor tower is constructed in two pieces. Each piece is rigidly attached to the superstructure at only one point; onto the gyro sensor pressure case. A system of guy wires is employed to fully capture the sensor tower inside the surrounding structure.

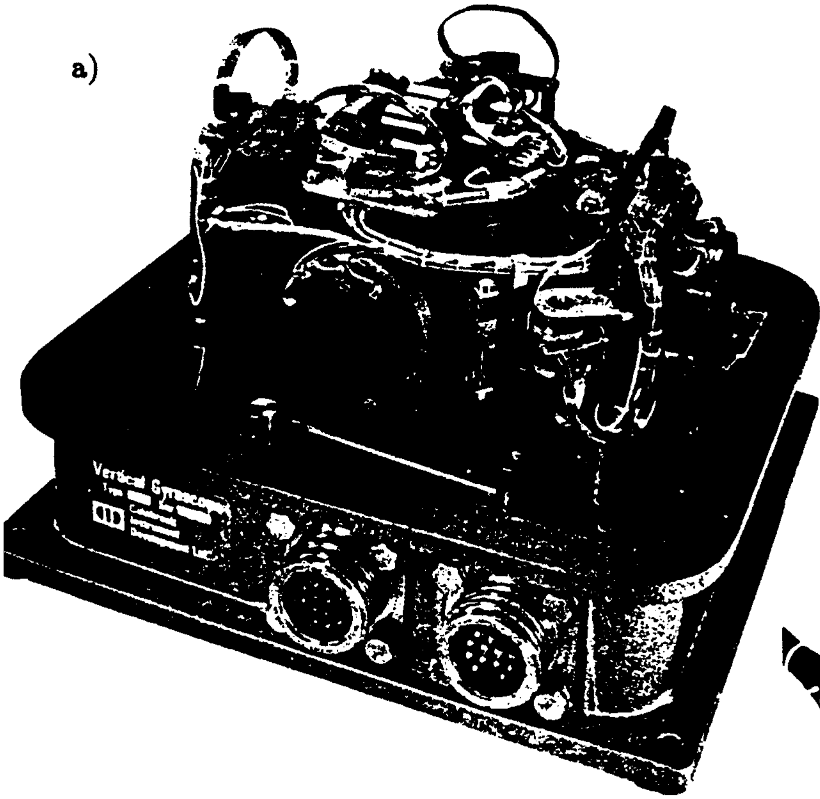
The heart of the motion sensing package is a two axis gyroscope manufactured by Colnbrook, a photograph of which is shown in Figure 4a. Three Sundstrand 2180 accelerometers were orthogonally mounted on the stabilized platform of the gyroscope; these fully determined the linear motions of the buoy. The gyro was equipped with capacitive type potentiometers on each of the gimballed axes so that the pitch and roll angles could be determined. Finally, the yaw angle was measured by a compass which was housed inside the BASS instrument case. The gyro in its pressure case with BASS sensor towers attached is shown in Figure 4b.

The suite of sensors on SASS was rounded out by a wavestaff, thermistors and conductivity sensors. The wavestaff, 47 inches long, was of the capacitive type and was mounted directly above the BASS velocity sensor tower. This was included in anticipation of the fact that the SASS would not follow waves which were shorter than twice its own horizontal length scale (12 ft). The wavestaff, then, gave some clue as to what the "slippage" was between the SASS and the shorter waves.

A metal-clad thermistor was mounted at each velocity sensing pod such that the sensing element of the thermistor was directly adjacent to the volume of water being sampled by the current meter. The metal clad thermistors were chosen because with their small size they presented a minimal disturbance to the velocity measurement. To supplement the metal-clad measurements, which are not very accurate in an absolute sense, a Sea-Bird thermistor was mounted at the same level as the top and bottom metal-clad thermistors. The Sea-Bird sensors, being quite large, were mounted on the aluminum frame; as far away as possible from the from the velocity sensors in the horizontal direction.

Mounted beside each of the Sea-Bird thermistors was a Sea-Bird conductivity sensor. These two conductivity sensors were included to provide additional information on the degree to which the water was mixed, by providing the conductivity gradient over the SASS's height.

a)



b)

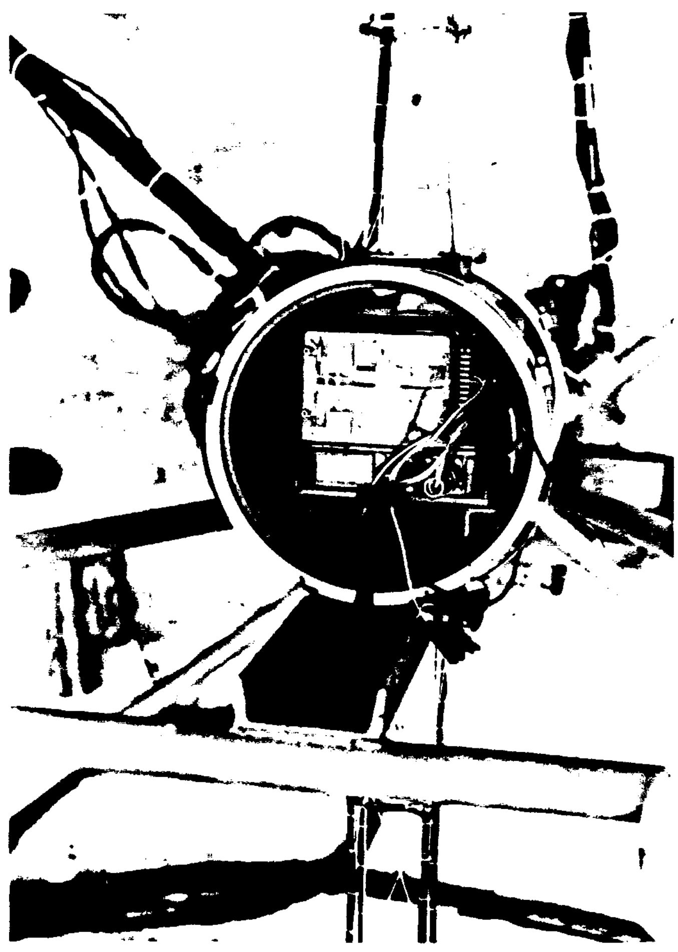


Figure 4: a) Photograph showing the central component of the motion sensing package, the Colnbrook gyroscope, with the top cover off.
b) The gyroscope shown with Tattletale controller attached, shown inside its pressure case on SASS.

3.2 Mooring

A single point moooring was used to keep SASS in position. In order to attach SASS to a single line, a three-part chain bridle was employed. The chain, covered with radiator hose, was attached to each of the lower verticies of the structure and joined together at a pear link twenty feet below the upper attachment points. One hundred fifty meters of line extended down to the primary, 1000 pound anchor. A secondary, 250 pound anchor was attached to the primary anchor with 125 meters of chain. Recovery of SASS was facilitated by a Norwegian float which was attached by 125 m of line to the secondary anchor. On recovery, the Norwegian float was brought on board first, followed by the anchors and then, finally SASS itself could be brought on board. A diagram of the SASS mooring is shown in Figure 5.

3.3 Data Recording: Telemetry, Recording and Control

All the data received from the sensors was multiplexed by the BASS current meter's computer and output as a 4800 baud UART signal. The BASS data records, as programmed for the SASS, are 89 bytes long, comprised of one and two byte words. There is no end of record mark, the only indication that a new record is starting is the header characters (in this case, AA 59). The data format for SASS data is as follows:

AA 59	header, # bytes following in record.
MO DA HR MN	date & time: 4 - 1 byte words
Q1 Q2 Q3 Q4	quality words: 2 bits/axis
V11_ V12_ V13_ V14_	velocities: 4 - 2 byte words per pod
V21_ V22_ V23_ V24_	
V31_ V32_ V33_ V34_	
V41_ V42_ V43_ V44_	
V51_ V52_ V53_ V54_	
V61_ V62_ V63_ V64_	
G1_ G2_ G3_ G4_ G5_	gyro: 5 - 2 byte words
T1_ T2_ T3_ T4_ T5_ T6_	temperature: 6 - 2 byte words
WVST	Wavestaff: 1 - 2 byte word
SC1_ ST1_ SC2_ ST2_	Cond/Temp: 4 - 2 byte words
CP	Compass: 1 - 1 byte word

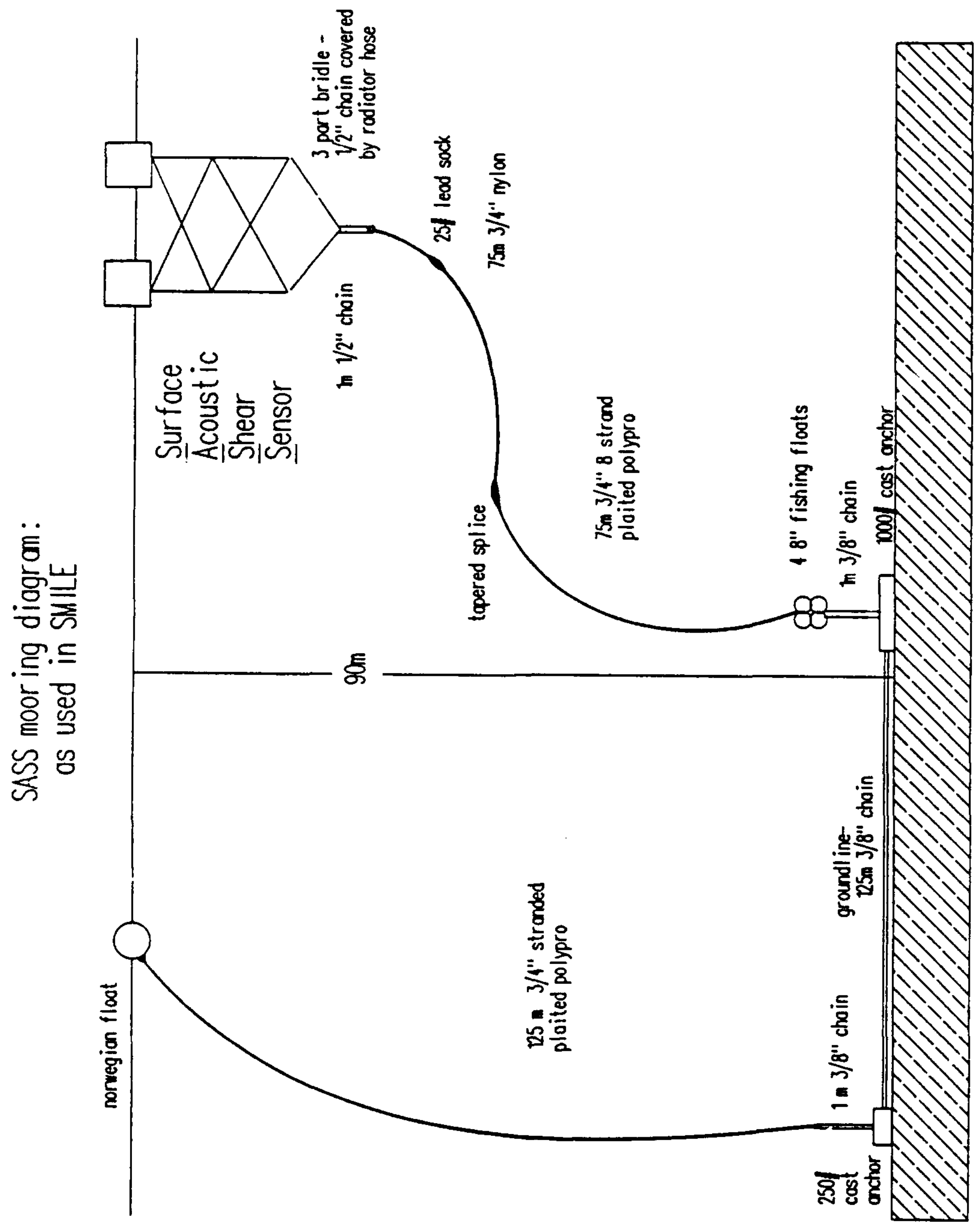


Figure 5: Diagram of the SASS mooring used during SMILE.

During a one hour data acquisition session, approximately 14,400 records is logged for a total of 1.3 Mbytes in the file for that hour's data. Each time data was collected it was written to a new file, containing only that session's data.

During the fall 1988 deployment, all of the data taken was transmitted via Clegg FM transceivers and logged on NEC personal computers on either ship or shore. FCC approval was obtained for the frequencies used for the data and command transmission. Because some of the records taken were marred by extremely high dropout rates it was decided that for the second deployment an optical disk drive would be added to the SASS itself for internal recording. The system employed was a LOPACS which is manufactured by Star Engineering and utilizes a NHance optical disk drive.

The gyroscope, the radio transceiver, and the optical disk logger all consume considerable amounts of power, so it was not possible to log data continuously. Therefore, some system of controlling the instrument was necessary. To this end a Tattletale IV computer, manufactured by Onset Computers, was installed as a controller inside the gyro pressure case. The Tattletale turned the sensors on and off by triggering an FET switching circuit with its I/O lines. Shipboard (or onshore) control was accomplished by transmitting DTMF (dual tone, multi frequency) signals over the radio which were decoded by a DTMF chip included in the SASS controller circuitry and consequently interpreted by the computer as a command. The commands and their meanings (as defined for the spring 1989 deployment) are given in Table 3.

TABLE 3: SASS DTMF Control Command

DTMF Tone	Action
1	start gyro motor
2	uncage gyro, apply high erection voltage
3	10 sec. test transmit
4	switch to low erection voltage
5	all off, cage gyro
6	1 minute transmit
7	20 minute transmit
8	1 hour transmit
9	2 hour transmit
10 (0)	2 hour transmit & optical disk
11 (*)	2 hour optical disk record
12 (#)	2 hour optical disk record

The start-up procedure for each data sample involved several steps. When not taking data the gyroscope is physically restrained from tilting by caging bars (this is done to prevent the gyro from banging around while its motor is off). As a prelude to uncaging the gyro the motor is allowed to spin-up for about two minutes (this is done by entering command 1). Once the motor is spun-up the caging bars of the gyro can be released and voltage is applied to the gyro's erection coils (command 2). These coils apply small forces to the gyroscope, forcing it to be level with respect to a horizontal plane established by averaging the output of small, level-seeking mercury switches. It takes approximately five minutes for the gyro to find level. If it was so desired the erection voltage could be lowered from twelve volts to five volts by entering command 4; this effectively increases the averaging time of the gyro's level seeking. This, however, was never used in either of the deployments. With the gyro motor spinning and uncaged one may start taking data (the BASS has a warm-up time on the order of milliseconds) by entering one of the command options from 6 to 12.

Upon completing a data transmission or an optical disk logging segment, the gyro remains powered-up and if it is desired to take another data sample one may immediately begin to collect data without restarting the gyro. However, if no more data is to be taken the entire system may be shut down (command 5) to conserve power. Additionally, the Tattletale was programmed to automatically shut down the entire system if no data has been taken or no new commands have been recieved for twenty minutes.

3.4 Batteries

As mentioned previously, some of the instruments on board SASS drew large amounts of power. Therefore, it was necessary to put large amounts of batteries on SASS and to keep a detailed battery budget during each deployment. The power for SASS came from 12 volt, 23 amp-hour Gell Cell batteries. As shown in Figure 2, the batteries were stored in the floats at the top of the buoy. Also stored in the battery wells were the radio transceiver and on the second cruise, the LOPACS optical disk logger. The BASS computer requires a 24 volt input and therefore was run off two batteries connected in series. All other systems were run on 12 volt batteries connected in parallel. On the first deployment a total of eighteen batteries were stored in the battery wells. On the second deployment only sixteen batteries could be carried as it was necessary to displace two batteries in order to make room for the optical disk logger.

The 12 volt supply was the one which limited the operational life of the buoy, so it was only necessary to accurately keep the battery budget for those batteries which were connected in parallel. The battery budget for the SASS configuration which includes the optical disk logger is as follows:

$$14 \text{ batt} \times 1380 \text{ amp-min/batt} \times 1/2 \text{ (degradation factor)} = 9660 \text{ amp-min}$$

The estimated current drain rates of each of the devices supported by the twelve volt batteries is as follows:

radio transmitting	= 2.0 amps
radio "listening"	= 0.15 amps
gyro system	= 1.5 amps
optical disk logger	= 2.4 amps

The degradation factor for the batteries may seem too severe, as the battery specification only derates the battery to 90 % of its stated capacity for temperature. The rest of the derating in the 1/2 above is to compensate for the decreased current compliance of the batteries with discharge. So while the voltage level was nominally twelve, the end-of-life is reached earlier than expected because the batteries can not supply the 3.5 amps at the 12 volts necessary to run the gyro and radio simultaneously. The 1/2 factor was initially an educated guess, but was subsequently found to be a realistic derating.

Now, with the estimates above, the maximum amount of data it is possible to receive is a total of 46 hours. This assumes that one takes 46 hours of data continuously after deployment using only the radio to transmit the data. Because data is taken selectively over time some power was used up with the radio in listening mode. Further, the optical disk system is sometimes used instead of the radio telemetry system and sometimes the radio and optical disk system are used simultaneously and therefor the actual amount of data recovered will fall somewhat short of the optimal 46 hours.

4 Cruise Logs for SASS Work

4.1 Deployment 1: 11/26 – 12/8/88

The first deployment of SASS lasted eleven days and spanned three short cruises on the R/V WECOMA. The dates are summarized in Table 1. During this time data was collected from SASS, the STRESS tripods were deployed and CTD stations completed. Appendix 1 provides a summary of all the SASS data logged during the first deployment.

After completing pre-cruise zeros at the dock, the WECOMA departed Sausalito November 27 at 1300. The ship arrived at the C3 mooring site at 2000. Due to the calm conditions, the decision was made to deploy SASS immediately, slightly to the northeast of C3 in 90 meters of water. The SASS mooring deployment was completed by 2300, with SASS at 38° 38.88'N 123° 29.32'W, and the secondary float at 38° 38.98'N, 123° 29.40'N. Radio transmission was then commanded by the ship, and data successfully received. The first actual data record logged was taken at 0015 on November 28. Collection of additional data records continued when possible around the other work of the cruise, sometimes interspersed with STRESS radio telemetry. The conditions were not stormy, so to conserve batteries, not many data sets were collected. The wavestaff was observed to be bent 10 - 20 degrees from vertical at 1420 November 28. It was hypothesized that some of the seaweed floating in the area had been trapped against the wavestaff, pushing it over before becomming free. The other deployments and CTD work of the cruise were completed November 30 at 0300. The control of data acquisition from SASS was transferred to the land station at Sea Ranch at this time. The ship then started the transit back to Sausalito, and was at the dock by 1630.

During attempted data acquisition from Sea Ranch on December 1, the SASS did not respond to transmitted commands. The radio quieted, indicating that the transmitter was being keyed, but no BASS data was present. This suggested that some fault allowed the BASS battery to run down. Fortunately, the weather continued to be calm and balmy, so the malfunction did not cause the loss of storm data. The group in Sausalito was notified that the batteries were down, and plans were made to work on SASS during the upcoming leg.

The next cruise leg departed Sausalito December 2 at 0730, and the WECOMA was on site by 1500. The weather remained fair, work progressed, and SASS was recovered for battery recharging and trouble shooting at 1500 on December 3. The SASS was redeployed on December 4 at 1600 with newly charged batteries and a straightened wavestaff. The new position for SASS was 38° 38.93'N 123° 29.38'W. Sea Ranch was able to receive data again, so control of data acquisition returned there. The rest of the STRESS deployments and CTD stations were finished by the evening of December 5. The transit back to Sausalito was completed in time for the morning tide on the sixth.

Data logging at Sea Ranch continued while the WECOMA was not in the area. On December 6 during the 1800 data transmission, the battery died again. Since there was not time to recover, recharge and redeploy, this was the last data received during deployment 1.

The WECOMA left Sausalito at 0800 December 7 for the final STRESS deployment leg and to recover SASS. The information that the battery was dead again was conveyed to the ship in the evening. As surmised, there was no time to recover and redeploy, and the deployments and other work of the cruise had to be completed before SASS could be recovered. The wind and seas finally kicked up on December 8, making shipboard operations more difficult. The secondary float on the SASS mooring was not on the surface for much of the cruise, so alternate recovery methods were discussed. The float returned to the surface by noon on December 9, so recovery operations were commenced soon thereafter. The SASS was on deck by 1600, and once it was tied down, the ship began the transit to Sausalito. The WECOMA was at the dock at 1000 December 10, and unloading was started.

4.2 Deployment 2: 2/23 – 3/14/89

The second deployment of SASS again spanned three WECOMA cruise legs. This time the SASS mooring stayed in the water longer and more hours of data were logged. The problem that caused the BASS battery to run down prematurely in deployment 1 was corrected in Woods Hole, and logging to optical disk to provide backup for the radio telemetry was implemented between deployments. Appendix 2 contains a summary of the data collected during the second SASS deployment.

A pre-cruise zero was done in Sausalito at 2000 February 22. The WECOMA departed for C3 at noon on February 23, arriving at the C3 site at 1900. The weather was good, so SASS was deployed immediately. The mooring was set at 2130 in nearly the same position as the last time: 38° 38.83'N 123° 29.97'W. Tests were done on both the radio telemetry and optical disk logging systems, and both appeared to be functioning as expected. The dropout rate on the radio telemetry link was 4% or less when within a mile of SASS and the logging program was terminated before the data transmission stopped. It was also observed that the range in which telemetered data can be received well was smaller than expected (when 3 miles from SASS dropout was 21% and at six miles, 38%), but logging to the optical disk was often possible when radio transmission was not. The weather was calm again, so to conserve batteries, little data was taken on the 24th.

The receiving station at Sea Ranch was operational by the evening contact on

February 25, and at 2215 a two hour transmission to calibrate the receiver at Sea Ranch was started. Since the weather continued calm, it was decided not to take more data. The wind picked up to an average speed of 20 kts on February 27, so several data records were taken. The winds were gusting to 38 kts during the night, so the two hour records at 2055 and 0100 on the 28th should contain the kind of data desired. The decision was made not to recharge and redeploy SASS before returning to Sausalito, due to the potential for damage to the SASS on recovery or redeployment. Since the battery had already been about half used, it was important to choose events for data collection carefully, so as not to use the battery unnecessarily. Sea Ranch took control of the logging most of February 28 while the WECOMA was out of range of SASS. The WECOMA started back to Sausalito at 2200 February 28 and arrived in port at 0700 March 1.

The next WECOMA leg was all hydrography, so control of SASS remained at Sea Ranch. The weather was very calm the morning of March 1, but by evening conditions had really picked up and a pair of two hour events were logged that night. More data was taken the morning of March 2, but by afternoon the winds were dropping. Logging was suspended after taking a "winding down" data set. Given the battery constraints, conditions did not warrant taking data March 3 or 4. The weather report for March 5 indicated a approaching storm, so the start-up sequence was begun to capture the beginning of the storm. When attempting to complete the start-up, no commands could be entered after the gyro motor was started. The batteries were evidently low enough that the gyro motor drew the voltage way down. The SASS transmission was strong though, so data was collected from everything except the gyro. Upon analysis this data was found to be badly corrupted and probably unusable, so data acquisition was terminated. The station at Sea Ranch was used for programming and data analysis during the time between March 5 and 11 when the gear was dissassembled and returned to Sausalito.

The SASS recovery cruise departed Sausalito March 12 at 1600. The C3 site was reached later that night, and work was started to find the correct position to deploy the STRESS radio buoy. Other work of the cruise continued until 1400 March 13, when recovery of SASS was begun. The conditions were the worst SASS had been handled in, with rain, 15+ knot winds, and 12 foot seas. Despite the weather, SASS was safely onboard at 1530. Sometime during the deployment, one of the central horizontal braces fell off, due to the attachment bolts having loosened and fallen off. Minus this brace, the SASS frame was much less rigid, and the BASS sensor towers became more vulnerable. The BASS towers were twisted in several places, but until the data is analysed, there is no way to know when this occurred. The wavestaff had also been bent again, sometime after February 28. Again, analysis of the data will provide information on when it was bent. Otherwise, the structure stood up well to the 20 day deployment in some of the most severe weather seen during the winter. The WECOMA returned to port at 0630 March 14, having completed the last of the work associated with the SASS component of the SMILE experiment.

5 Data Aquisition Results

During SMILE, SASS was deployed for a total of 31 days, during which 53 hours of data sampled at 4z were acquired. Data was collected during a wide range of atmospheric conditions. Very calm periods, as well as a time with 35 knot winds and 15 foot seas are represented. Most of the rough weather data was collected during the second deployment, as a high pressure air mass was stalled over the experimental area for most of the first deployment.

All the data obtained during the first deployment (11/26 - 12/8/88) were telemetered to ship or shore using VHF radio telemetry, and logged on a personal computer. A total of 17 hours of data were acquired, which is good considering that a small electronics problem caused the batteries to be expended much faster than expected. This data may have slightly more errors than that from deployment 2, as the radios were not perfectly adjusted for some of the first deployment.

The second deployment (2/23 - 3/14/89) saw the battery consumption problem fixed and the addition of logging to an optical disk mounted in one of the SASS floats implemented. The performance of SASS was excellent during the second deployment. A total of 36 hours of data were collected, 26 hours using radio telemetry, 10 hours logged directly to optical disk, with 2 hours logged both ways simultaneously. The data from February 27 to March 2 ($\sim$ 20 hours) should provide very interesting information on surface mixing during storms.

The analysis of the SASS data is underway. Since this is a new instrument, some of the data analysis methods are still being developed. There is also a large amount of data to be treated, so the data processing may take some time to complete. The data and methods used to analyse it will be presented in another document at a later date.

6 Acknowlegements

The authors wish to thank A.J. Williams III and C.V.R. Dunn for their assistance with planning and execution of the experiment. The work of S. Kery and P. Clay in designing the SASS mooring, and E. Terray in implementing the optical disk logging and planning analyses is greatly appreciated. The officers and crew of the R/V WECOMA did a fine job of handling the ship for deployments and recoveries. We also wish to thank J. White for her patience in preparing this report, and B. Pratt for helping with the figures. This research was conducted under NSF Contract Number OCE-8716937.

7 References

Williams, A.J. 3rd, J.S. Tochko, R.L. Koeler, W.D. Grant, T.F. Gross, and C.V.R. Dunn, 1987. "Measurement of Turbulence in the Oceanic Bottom Boundary Layer with an Acousitc Current Meter Array". *J. Atmos. and Oceanic Tech.*, 4(2), June, 1987, pp. 312-327.

Appendix 1

Initial SASS Deployment Data Collection Summary

Date	Start Time	Duration	logging On Ship	logging Sea Ranch	Comments
11/27/88	2300				SASS deployed at 38° 38.88'N 123° 29.32'W
11/28/88	0015	20 min	√		
	0042	2 hrs	√		
	0635	2 hrs	√		wind speed 5 kts, 330°
	1832	20 min	√		wave staff bent by seaweed
	1903	20 min	√		
	2002	20 min	√		wrong channel - data not good
	2037	20 min	√		
11/29/88	1500	20 min			
	1550	20 min		partial	calibrating receiver volume at Sea Ranch
	1644	20 min			calm weather
11/30/88					no data collected
12/1/88	1200				BASS battery dead; responds by quieting only; no data
12/3/88	1600				SASS recovered for battery recharge
12/4/88	1500				SASS redeployed at
	1958	20 min		√	to recheck function and receiver level
	2100	2 hrs		√	
12/5/88	0845	1 hr		√	
	1046	1 hr		√	more parity/framing errors than expected
	1600	1 hr		√	
	1700	1 hr		√	
	2040	1 hr		√	
	2154	1 hr		√	
12/6/88	1200	1 hr		√	
	1800	1 hr		√	battery died during this transmission end of logging
12/8/88	1600				SASS recovered by R/V WECOMA

Appendix 2

Final SASS Deployment Data Collection Summary

Date	Start Time	Duration	Ship	logging Sea Ranch	on SASS Opt. Disk	Comments
2/23/89	2140					deploy SASS 38° 38.83'N 123° 29.37'W
	2144	20 min	√			
	2210	2 hr			√	
2/24/89	0820	2 hrs	√		√	
2/25/89	2215	2 hrs	√	partial		this run used to calibrate the volume level on the receiver at Sea Ranch. Also CTD at C3 at same time.
2/26/89	0000	1 hr		√		
2/27/89	0705	2 hrs			√	
	1020	2 hrs		√		
	1310	2 hrs		√		
	1529	20 min	√	√		coordinated with video of SASS-CTD at C3
	1555	2 hrs	√	√		winds picking up
	2055	2 hrs		√		good windy/stormy weather
2/28/89	0100	2 hrs			√	good windy/stormy weather
	0930	2 hrs		√		
3/1/89	2125	2 hrs		√		raining and windy
	2326	2 hrs			√	
3/2/89	0830	2 hrs		√		raining and windy
	1030	2 hrs		√		raining and windy
	1550	2 hrs		√		raining and windy
	1905	2 hrs		√		wind dying, seas heavy
3/3/89 3/4/89						very calm - no data taken - battery power limited, so conserving
3/5/89	0900	20 min		√		battery too low to run gyro, but collecting current and temperature data end of SASS data collection
3/14/89	1530					SASS recovered by R/V WECOMA

DOCUMENT LIBRARY
July 5, 1989
Distribution List for Technical Report Exchange

Attn: Stella Sanchez-Wade
Documents Section
Scripps Institution of Oceanography
Library, Mail Code C-075C
La Jolla, CA 92093

Hancock Library of Biology &
Oceanography
Alan Hancock Laboratory
University of Southern California
University Park
Los Angeles, CA 90089-0371

Gifts & Exchanges
Library
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS, B2Y 4A2, CANADA

Office of the International
Ice Patrol
c/o Coast Guard R & D Center
Avery Point
Groton, CT 06340

Library
Physical Oceanographic Laboratory
Nova University
8000 N. Ocean Drive
Dania, FL 33304

NOAA/NESDIS Miami Library Center
4301 Rickenbacker Causeway
Miami, FL 33149

Library
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, GA 31416

Institute of Geophysics
University of Hawaii
Library Room 252
2525 Correa Road
Honolulu, HI 96822

Library
Chesapeake Bay Institute
4800 Atwell Road
Shady Side, MD 20876

MIT Libraries
Serial Journal Room 14E-210
Cambridge, MA 02139

Director, Ralph M. Parsons Laboratory
Room 48-311
MIT
Cambridge, MA 02139

Marine Resources Information Center
Building E38-320
MIT
Cambridge, MA 02139

Library
Lamont-Doherty Geological
Observatory
Colombia University
Palisades, NY 10964

Library
Serials Department
Oregon State University
Corvallis, OR 97331

Pell Marine Science Library
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882

Working Collection
Texas A&M University
Dept. of Oceanography
College Station, TX 77843

Library
Virginia Institute of Marine Science
Gloucester Point, VA 23062

Fisheries-Oceanography Library
151 Oceanography Teaching Bldg.
University of Washington
Seattle, WA 98195

Library
R.S.M.A.S.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Maury Oceanographic Library
Naval Oceanographic Office
Stennis Space Center
NSTL, MS 39522-5001

Marine Sciences Collection
Mayaguez Campus Library
University of Puerto Rico
Mayagues, Puerto Rico 00708

01

ORT DOCUMENTATION PAGE | 1. REPORT NO. WHOI-89-34 | 2. | 3. Recipient's Accession No.

and Subtitle

Surface Acoustic Shear Sensor (SASS) as used during the Shelf MIxed Layer Experiment
LE), November 1988 – March 1989

5. Report Date
July 1989

6.

or(s)
n T. Montgomery and Markku J. Santala

8. Performing Organization Rept. No.
WHOI-89-34

rming Organization Name and Address

Woods Hole Oceanographic Institution
ods Hole, Massachusetts 02543

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C) OCE-87 16937
(G)

onsoring Organization Name and Address

artment of Applied Ocean Physics and Engineering

13. Type of Report & Period Covered
Technical Report

14.

pplementary Notes

s report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-89-34.

stract (Limit: 200 words)

The SMILE (Shelf MIxed Layer Experiment) field program took place during the winter of 1988-1989. The SMILE program lf was large and involved many investigators and instruments. This report documents the use of the Surface Acoustic Shear Sensor SS) as part of the suite of measurements taken during SMILE.

The SMILE mooring array was deployed from early November 1988 until June,1989. SASS, being a newly developed trument, was deployed for two shorter periods; a test deployment between November 26 and December 8, 1988, and a longer second ployment, February 23 through March 14, 1989.

SASS is based on BASS (Benthic Acoustic Stress Sensor) components (Williams et al., 1987), mountedon a structure that owed continuous sampling of velocity, temperature and conductivity in the top five meters of the ocean. BASS was modified for this face application to acquire data from a gyro, and conductivity sensors. The attitude data from the gyro allows the velocities of the rent meter to be referenced to an inertial frame of reference. The other data obtained from SASS will be used to calculate shear current dients, and other descriptors of turbulence and mixing.

cument Analysis a. Descriptors

surface mixing
turbulence measurements
surface acoustic shear sensor (SASS)
telemetry/remote control

Identifiers/Open-Ended Terms

COSATI Field/Group

ailability Statement	19. Security Class (This Report)	21. No. of Pages
pproved for publication; distribution unlimited.	UNCLASSIFIED	19
	20. Security Class (This Page)	22. Price

SI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce